



The Economics of Anaerobic Digestion with Co-Product Marketing

C. Richard Shumway

Clark P. Bishop

School of Economic Sciences

Economic Analysis

- Investment, operation, and projections based on operational digester
- Use common indicators to gauge economic performance
- Consider several co-product marketing scenarios
- Results have implications for conditions under which digesters likely to be economically viable

Base Digester

Use investment, operation, and financial records of VanderHaak digester



Base Digester

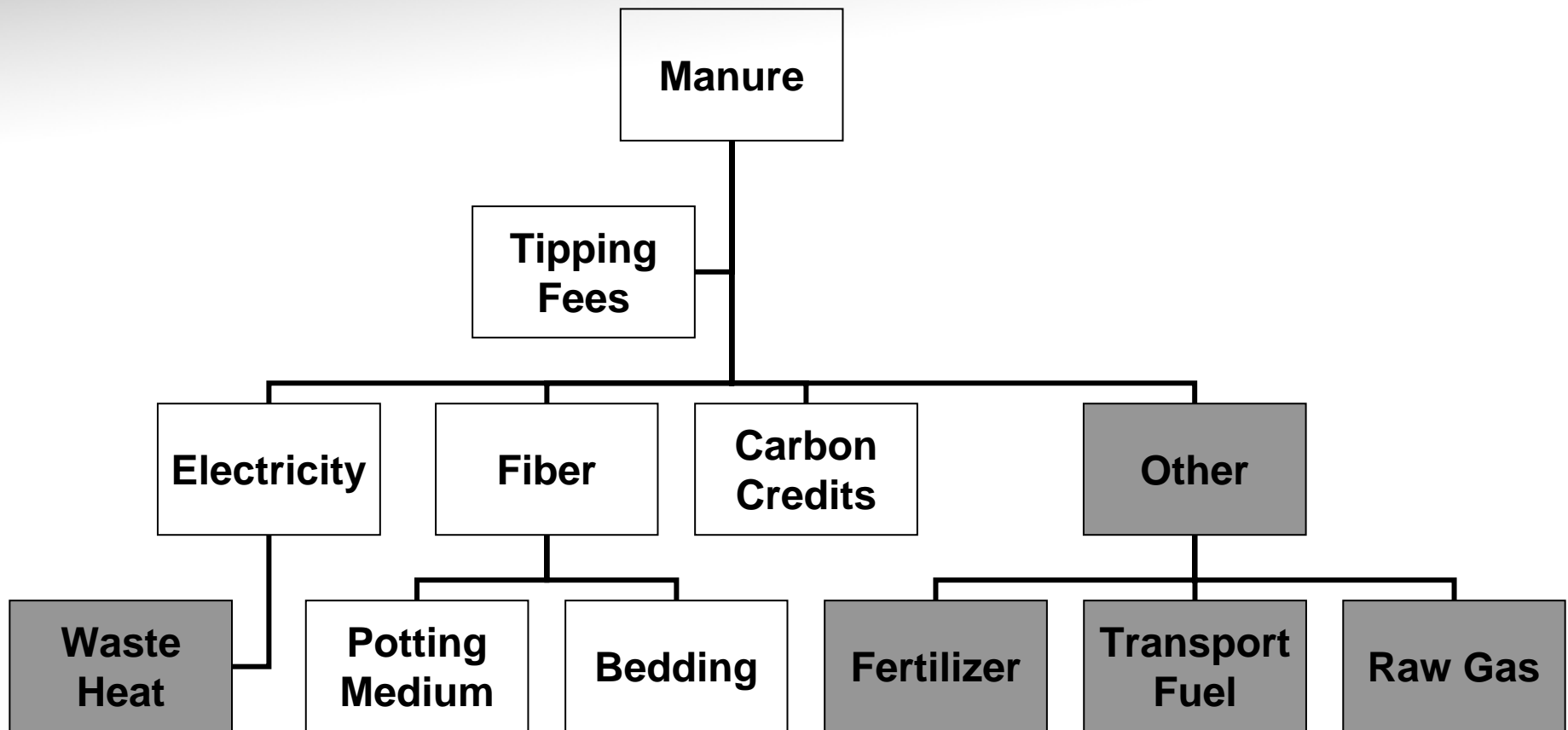
- Assess economics of actual co-products:
 - Electricity
 - Digested fiber
 - Carbon trading
 - Tipping fees



Base Digester

- Potential co-products not assessed
 - Struvite
 - Scrubbed methane
 - Waste heat

Possible Digester Co-Products



Economic Indicators and Conditions

- Pre-tax economic indicators
 - Net present value (NPV)
 - Internal rate of return (IRR)
- Assume producer is risk neutral
- Use a real discount rate of 4.0% – approximate average rate of return to equity in U.S. farming
- Base digester: VanderHaak
 - Used actual investment and first 2 ¼ years of operational data
 - Made plausible projections for 20 years of operation

VanderHaak Digester

- Treated digester as independent enterprise
- Maximum capacity – 1,500 cows
- Built on 500-cow dairy
- Manure from additional 250 cows trucked in
- Received food waste from local food processors
- Total investment (construction) cost: \$1,136,364
- Grants covered 38% of investment cost
- Contractual electricity rate (including green tags): \$0.05 per kWh
- Digested fiber used for bedding and sale
- Carbon credits sold on the Chicago Carbon Exchange

Base Digester Scenario

Gross Revenue	Expected
Electric Sales	97,088
Tax Credit	38,835
Avoided Bedding Costs	18,000
Tipping Fees	111,767
Digested Fiber	6,319
Carbon Credit	14,527
Total Revenue	286,536

Operating Costs	Expected
Manure Delivery	32,778
Maintenance	69,060 – 92,008
Utilities	6,000
Other	13,059
Total Operating Expenses	120,894 – 143,842

Building to Base Digester Scenario

1. 500-cow herd with full investment cost
 - Selling electricity
 - Using fiber for bedding
2. #1 with investment cost net of grants
3. #2 plus trucked-in manure from 250 cows
4. #3 plus food wastes
5. #4 plus tipping fees
6. #5 plus sale of excess fiber
7. #6 plus sale of carbon credits (Base Digester)

Alternatives to Base Digester

- Higher and lower real discount rate – 3.0% and 5.0%
- Longer physical depreciation period – 30 years
- No power generation
- Digester built on 1,300-cow dairy
- Sell all digested fiber at \$13.50 or \$20 per ton
- Carbon brokerage fee cut in half or have access to European carbon market

Selected Findings for Base Digester

	<u>NPV</u>	<u>IRR</u>
1. 500-cow herd, electricity & fiber for bedding	-\$0.6M	—
2. #1 with investment cost net of grants	-0.2M	2.0%
3. #2 plus trucked-in manure from 250 cows	-0.7M	—
4. #3 plus food wastes	-0.4M	-3.3%
5. #4 plus tipping fees	1.1M	17.1%
6. #5 plus sale of excess fiber at \$13.50/cy	1.2M	18.1%
7. <u>Base Digester</u> : #6 plus sale of carbon credits	1.4M	20.0%

Findings: Alternatives to Base Digester

	<u>NPV</u>	<u>IRR</u>
7. <u>Base Digester</u>	<u>\$1.4M</u>	<u>20.0%</u>
8. Base with 3% real discount rate	1.6M	20.0%
9. Base with 5% real discount rate	1.2M	20.0%
10. Base with 30-year physical depreciation	2.0M	20.5%
11. Base with no power generation	0.3M	9.3%
12. Base with 1,300 cows and no food waste	1.3M	19.3%
13. Base with all digested fiber sold for \$13.50/cy	1.4M	20.7%
14. Base with all digested fiber sold for \$20/cy	1.6M	22.7%
15. Base with 25% commission on carbon trading	1.5M	20.9%
16. Base with carbon trading at ECX price	2.2M	27.4%

Decision making

- Base digester potentially economically attractive
- Digesters not just biogas generators
- Co-product markets essential for economic viability
- Tipping fees essential for viability unless dairy uses digester near capacity

Decision making

- Trucked-in manure not economic without tipping fee
 - Non-economic value from buffering capacity
- Prospects for assuring viability:
 - Mature carbon credit market
 - Increased value and market for digested fiber
 - Development of other co-product technologies and markets
- Potential as holistic, sustainable conservation technology and energy source